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TO: Kenneth R. Stroud, Chief
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FROM: Reggie Smith, Manager
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DATE: October 7, 2005

SUBJECT: BAM-1020 "Q-TOT" ISSUES AND DATA VALIDATION /FLAGGING

Over the past several years there have been some ambient air monitoring episodes, which have resulted in unusually high BAM-1020 hourly values for particulate matter less than 2.5 microns in aerometric diameter (PM2.5) concentrations. These events have occurred regularly on the evening of July 4, 2005 corresponding with firework displays and during various wildfire events. During these episodes it has been noted that the Met-One Instruments BAM-1020 Qtot values (total volume of air sampled during sample period) have been outside of Air Quality Surveillance Branch (AQSB) Standard Operating Procedure (SOP) requirements. Current AQSB procedures require a Qtot range of 0.830 to 0.837 cubic meters (m^3) in order to validate an hourly measurement.

In the past, AQSB policy has been to delete any data where Qtot values are out of the accepted range. However, this policy has lead to deleting some BAM-1020 data points with high hourly PM concentration values. While the quantitative value of the data may be in question, there may be some qualitative value to these data values.

A review of the flow curves for the Sharp Cup Cyclones (SCC's)(attached), shows that the SCC's cut-point remains effective with flowrates as low as 14 liters per minute (LPM) (cut-point = 3.0 μm). Based on this fact, a BAM-1020 Qtot value as low as 0.700 $m^{3,}$ which corresponds to an average flowrate of 14 LPM, may still provide data with some qualitative value. High Qtot values are rarely seen, but an upper limit of 0.900 m^3 would be appropriate for flagging data with high flow.

Therefore, the Operation Support Section is recommending making the following changes to AQSB policy regarding the review of BAM-1020 data:

1. Keep the current 0.830 to 0.837 m^3 Qtot range for BAM-1020 data validation.

2. Add a new flag to the AQDASII and AQS systems to encompass BAM-1020 data with Qtot values in the range of 0.700 to 0.829 m^3 and 0.838 to 0.900 $m^{3.}$ BAM-1020

data having Qtot values falling in these ranges would not be deleted but flagged as **"W, FLOW RATE AVERAGE OUT OF SPEC."** BAM-1020 data with Qtot values lower than 0.700 and higher than 0.900 m^3 would be deleted from data for record.

Given these additional data validation/flagging criteria, the semi-monthly flow rate checks (flows of 16.7 LPM +/- 4%) and leak checks (less than 1.0 LPM) remain unchanged and <u>are the primary validation criteria for hourly BAM-1020 data</u>.

Attachment

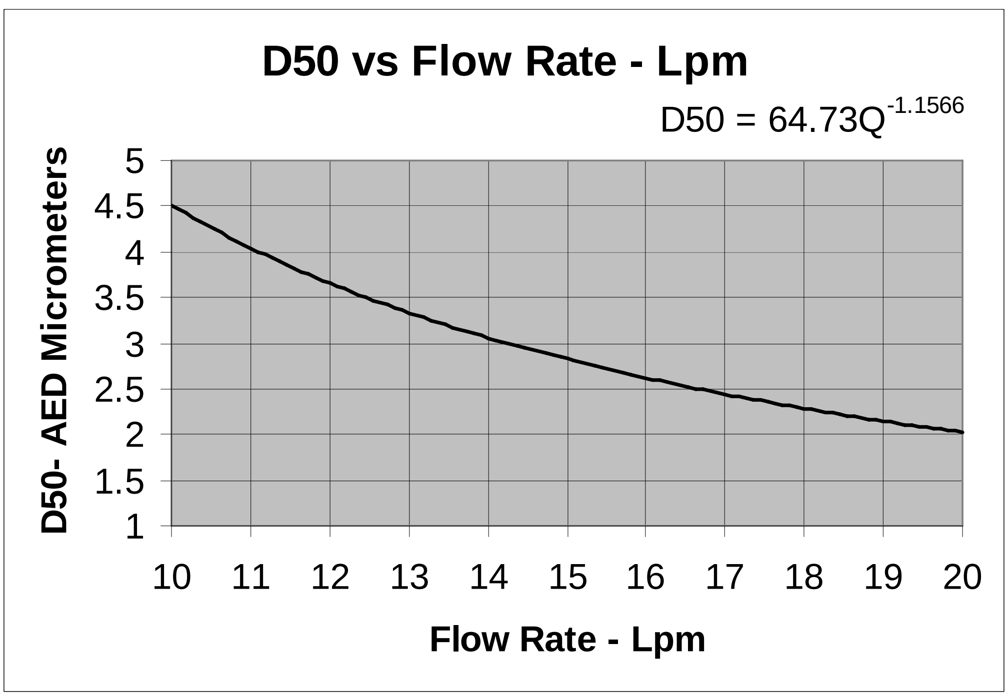
cc: William V. Loscutoff
Karen Magliano
AQSB Staff

The *Aerodynamic Equivalent Diameter* (AED) of a particle is a description or definition which depends upon the measurement technique of the particle property and behavior in a media. AED is a common term used in aerosol science which refers to a how a particle acts when suspended in air. When a particle is reported or measured using a sample technique, the measurement usually corresponds to a specific physical property.

In the case of ambient PM sampling the particle is suspended in air and the particle's physical diameter, density and shape can affect the settling velocity, independent of factors like wind and humidity.

The theoretical description of AED: The AED is the diameter of a unit-density sphere having the same gravitational settling velocity as the particle being measured. Normally this term is applied to particles >0.3 micrometers (µm) at atmospheric conditions, either indoor or ambient.

Inertial separators, PM Inlets and gravimetric filters samples are described by a cut-point of the particle, the AED.



Flow Rate versus Cut Off size @ 50 percent, Table 1

Example using a cyclone:

Cyclone is designed to have a cut-point to remove all particles greater than 2.5 µm AED. At 16.67 liters/minute sample rate the cyclone pulls in poly-disperse (multi size, shape and density) particles. Because the sample flow rate, density of media (ambient air) is moving at a constant velocity and the temperature, relative humidity and physical diameter of the inside vortex of the cyclone are fixed, then the particles will separate due their inertial size and density properties. Particles that "behave" as an equivalent to a physical diameter unit sphere having a "physical" diameter of 2.5 µm will pass through the device, particles that behave larger than a 2.5 µm particle will be removed in a collection cup. This would mean two particles entering the cyclone with different shapes and size and density may behave aerodynamically different, but may mimic the aerodynamic property of a 2.5 micron particle. Example is a pollen particle, fluffy with a physical diameter of 6 µm; if measured under a microscope. It enters the cyclone, but is collected onto the filter as a PM2.5 particle because it behaves aerodynamically as a PM 2.5 micrometer particle because of its inertial properties in the sampler. It is physically larger than a 2.5 micron diameter, but the density is light therefore in the air it behaves like a 2.5 micron diameter particle.

The *Cutoff Size* or *Cutoff Diameter* is referred to in aerosol science terms as ***d50***. The ***d*** is the particle diameter and ***50*** is mathematical description of particle penetration through an inertial separator.

To design an ambient particle inlet, cyclone or impactor the theoretical model to determine the particle separation is based on a 50% theoretical calculation. The d50 is generally assumed to be the particle size above or below which all particles larger than that size are collected. Since cyclones and impactors have a very sharp cutoff characteristic, almost all the particles larger than that size are collected. This description does not mean 50 percent of the particles of a certain size pass through. Actually it is a formula using many different values to describe how particles penetrate a device. In most cases of particle separation instrumentation the d50 is calculated at 50% but the actual collection efficiency and separation is near 100%. See the following figure. Note the intersection of the Very Sharp Cut Cyclone and EPA WINS is 2.5 micrometers AED. The steepness of the curve shows that the WINS and VSCC have a very sharp cut of separation of particles. The small "tails" at the top between 90 and 100% and bottom between 0 and 10% represents that the device has a small particle carryover since it is not 100% efficient.

1 Willeke, K., & Baron, P., “Aerosol Measurement, Principles Techniques & Applications”.